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EFFECTS OF TEMPERATURE AND HUMIDITY ON CELLULOSIC MATERIALS WITH SPECIAL REFERENCE TO TIRE CORD

A List of References

Compiled by John M. McNeill

THE ACTION of heat on textile fibers. Textile Colorist 61: 165-167. Mar. 1939. 306.8 T31
Discusses effects of heat on ductility, fiber structure, and dyeing characteristics.

ADAMS, J. T. Cotton, rayon and nylon as competitive tire fabrics. Rubber Age 56: 168-172. Nov. 1944. 305.8 R82
Characteristics of the different fabrics, including their reaction to heat.

ANDERSON, W. D. The Cotton cord, 1920-1940. 9 p. Macon, Ga., Bibb Manufacturing Co., 1940? 304 B47C
Properties and advantages of the Heat Resistant Processed Cotton Cord, developed by the Bibb company.

BELLINSON, H. R. Viscose rayon: stress-strain properties. III. Effect of relative humidity. Textile Res. 10: 372-379. July 1940. 304.8 T293
Tests showed that strength decreases and stretch increases as relative humidity is increased.

BLOW, C. M., and KNIGHT, W. Textile fibres and rubber as associated materials for manufacture. Textile Inst. Jour. 35: P7-P18. Jan. 1944. 73.9 T31
Brief reference is made to the weakening of cotton yarns by heat, which is explained as due to drying, which presumably reduces the bulk of the fibers and lessens the degree of fiber adhesion (p. P11). Figures are also given to show that with decreasing humidity and increasing temperature, viscose rayon cord is stronger than cotton cord.

BRADSHAW, W. H. Cordura - a new rayon yarn for tire cords. Indus. and Engin. Chem., News Ed. 18: 814-817. Sept. 25, 1940. 381 J825N
Properties of Cordura, a viscose rayon product, show a tensile strength equivalent to 70,000 pounds per square inch, low increase in elongation with rising load, increase in strength with diminishing moisture content (in contrast to cotton), a high degree of heat resistance, and a much nearer approach to uniformity than is true for natural cotton fibers. These properties produce a much greater range of usefulness for tires constructed with Cordura rayon than for cotton-cord tires.

BROWN, K. C., MANN, J. C., and PEIRCE, F. T. The influence of humidity on the elastic properties of cotton. Pt. V - The tensile behavior. Textile Inst. Jour. 21: T186-T204. Dec. 1930. 73.9 T31

Increase of relative humidity increased both the extension and load-carrying capacity of cotton fibers. Extension increased up to about 75 per cent relative humidity, above which there was only slight increase. Load-carrying capacity increased up to about 60 per cent relative humidity, above which the increase was very slight. Observations on the effect of temperature on wet hairs showed a slight weakening and an increase of extension with rising temperature.

BUSSE, W. F., and others. Fatigue of fabrics. Jour. Appl. Phys. 13: 715-724. Nov. 1942. 334.8 P563

E. T. Lessig, D. L. Loughborough, and L. Larrick, joint authors.

A test for fabrics was developed which measured the lives of samples at elevated temperatures when subjected to a constant average load with superimposed cyclic stresses. Under the conditions of the test, the change in service life was found to be much greater than the change in tensile strength. Results indicated that failures were due to a plastic or viscous flow process in the fibers; that the structure of a cord determined the concentration of stresses in the fibers at a given load; and that the material of which a cord was made was more important than its construction as a factor in useful life. Calculated activation energies for the plastic flow process increased for different fibers in the order rayon, cotton, nylon. Under conditions such that flow was negligible, the loaded cords tended to contract with raises in temperature.

CLAYTON, F. H., and PEIRCE, F. T. The influence of humidity on the elastic properties of cotton. IV - The rigidity of soda boiled cotton and effects thereon of history and temperature. Textile Inst. Jour. 20: T315-T332. 1929. 73.9 T31

DILLON, J. H., and PRETTYMAN, I. B. The effects of temperature and humidity on the physical properties of tire cords. Presented at Gibson Island Conference on Textiles, July 11, 1944. 26 p., processed. Akron, Ohio, The Firestone Tire and Rubber Co., 1944. 304 D58

Also in Jour. Appl. Phys. 16: 159-172. Mar. 1945. 334.8 P563

Description of experiments and apparatus in the investigation of tensile strength and creep of tire cords at different temperatures and relative humidities. Five representative types of cords were employed - medium-stretch cotton, low-stretch cotton, viscose rayon, Fortisan, and nylon. Results showed that the breaking strength of viscose rayon cords decreases with increasing temperature at constant moisture regain in the range of regains 0-5 per cent. The breaking strength of medium-stretch cotton cords at constant regain falls off with increasing temperature in the range of 20°- 100°C. and then changes very little up to 165°C. Breaking strength of the low-stretch cotton cords decreases in a manner similar to that found for rayon. The Fortisan cords show a decrease of strength in the range 20° - 100°C. and then a slight increase for higher temperature. The cotton, rayon and Fortisan cords give nearly linear creep curves in the range of creep times .002 to 20 hours. Nylon creep curves show a tendency to increase in slope at extended creep times. The creep data are analyzed in terms of "initial compliance" and "weighted creep."

FUWA, T. Some tensile properties of cotton yarn. Textile World 64: 3577, 3579, 3581. Dec. 15, 1923. 304.8 T315

Effects of moisture on tensile strength showed an increase of strength up to 12% moisture content. Above 12% there was no increase in strength. Stretch was unaffected by moisture content. Effects of temperature on tensile strength of bone-dry yarn showed a continuous decrease of strength with increases of temperature from 20° to 140°C., and a corresponding increase in stretch. Effects of both temperature and moisture content were found to be merely resultants of the separate effects of the two factors except at temperatures above 80°C., where moisture has but little effect. Baking the yarn at 110°C. for 8 days produced little effect on tensile strength; but at 140°C., baking for the same period of time reduced tensile strength by 50%. Fiber lubrication results in a lowering of the friction coefficient and and attendant decrease in tensile strength.

GURNEY, H. P., and DAVIS, E. H. The elastic properties of yarns, with special reference to tire cords. Textile Inst. Jour. 21: T463-T480. 1930. 73.9 T31

Study of the "nature of elasticity of tire cord, whence it arises, why it is of technical interest to tire designers and possible methods of measuring its value." The extent of intercorrelation between different measures of elasticity is also considered.

GURNEY, H. P., and DAVIS, E. H. Physical bases of tire cord properties. India Rubber World 77(6): 53-55; 78(1): 63-65. Mar.-Apr. 1928. 305.8 In2

Includes discussion of effects of temperature and humidity on cords (p. 64).

HEAT-resisting cord. Textile World 88(4): 60-61. Mar. 1938. 304.8 T315

Report of developments with regard to cotton cords.

HINDMAN, H., and FOX, K. R. Effect of relative humidity on load-elongation properties of certain fibers. Rayon Textile Monthly 24: 235-236, 287-289. May-June 1943. 304.8 R21

Study of yarns of acetate, viscose, cuprammonium, Cordura, Highnarco, Fortisan, and nylon. Summary table, p. 289.

KING, F. W. C., and TRUESDALE, R. Fatigue of fabrics in motor tyres. Textile Recorder 40(481): 88; 41(482): 86-87; (483): 99; (484): 103. Apr. 14, May 15, June 15, July 14, 1923. 304.8 T311

Study of the effects of tensile and bending stresses.

KNECHT, E., and MULLER, E. F. Some further notes on the action of heat on cotton cellulose. Soc. Dyers & Colourists. Jour. 41: 43-47. Feb. 1925. 306.9 Sol

A series of tests on cotton yarns showed that prolonged heating at 90° reduced the strength of the yarns in every case. Tests with higher temperatures were made to determine the scorch point of cotton cloth.

LARRICK, L. Tension vibrator compares tire-cord values. Textile World 95: 107-109, 194, 196, 198, 200, 202. May 1945. 304.8 T315

Includes temperature effects, and compares cotton and rayon cords.

LEADERMAN, H. Elastic and creep properties of filamentous materials and other high polymers. 278 p. Washington, D. C., The Textile Foundation, 1943. 304 L46

Partial contents: Effect of temperature on primary creep, p. 75-80; Effect of temperature variation, p. 82; Creep apparatus for study of temperature effect under dry conditions, p. 118-123; Creep properties of acetate rayon: temperature effect, p. 171-185; Effect of temperature on the creep properties of nylon, p. 209-228; Effect of relative humidity on the creep properties of nylon, p. 228-234.

LOASBY, G. Nylon yarn and its use in tyre cords. Inst. Rubber Indus. Trans. 20: 140-154. Feb. 1945. 305.9 In7

Includes effects of varying temperatures on properties of the yarns.

LYONS, W. J., NELSON, M. L., and CONRAD, C. M. Study of the "H" test for evaluating the adhesive properties of tire cord in natural and GR-S rubbers. U. S. Bur. Agr. and Indus. Chem. AIC-99, 56 p., processed. New Orleans, La., Southern Regional Research Laboratory, 1945. 1.932 A2Ag82

Includes effects of temperature on adhesion.

MANN, J. C. The influence of humidity on the elastic properties of cotton; on the breaking load at 20°C. Textile Inst. Jour. 18: T253-T264. 1927. 73.9 T31

Also in British Cotton Indus. Research Assoc. Shirley Inst. Memoirs 6: 53-64. Mar. 1927. 72.9 B773

Tests showed that breaking strength of cotton hairs increased 10-15 per cent with increase of relative humidity from 44 to 66 per cent. Increase in strength was insignificant above 66 per cent R. H. At 10 per cent R. H., strength of hairs was indicated as 120 per cent of dry strength.

NEWTON, R. B. Development of heat resistant cord. Rubber Age 42: 311-312. Feb. 1938. 305.8 R82

Characteristics of cord developed by the Bibb Manufacturing Co., Macon, Ga.

PHILIPP, H. J., and CONRAD, C. M. Control of elongation in highly stretched cotton tire cord. Jour. Appl. Phys. 16: 32-40. Jan. 1945. 334.8 P563

Investigation of the effects of heat and humidity in the conditioning and strengthening of tire cords under 10-pound tension showed that stretching strengthened the cords, but reduced their gauge and elongation. This effect was produced under various single-stretch treatments, employing varying degrees of temperature and moisture. A method of dual stretching was devised which made it possible to control elongation independently of strength of the cord.

ROGOVIN, Z. A., KARGIN, V. A., and SMIRNOV, U. Effect of high temperature on fibers. Tekstil. Prom., No. 3, p. 40-42. 1941.

"Cotton fibers, cuprammonium rayon and viscose rayon were tested for tensile strength and elasticity at 20 and 120°. The latter temperature was chosen because such a temperature was observed in the cord layers of automobile tires after long running. On the basis of many experiments which are explained in 7 tables it was shown that cotton fibers and cuprammonium rayon lost 30-40% of their tensile strength, whereas viscose rayon gained 5-7%. Linen and ramie fibers acted similarly to cotton fibers. The authors explain these reactions by the differences in the microstructures of the fibers." - Chem. Abs. 37: 6134. Oct. 20, 1943. 381 Am33C

ROSE, L. High tenacity viscose rayons. Soc. Dyers and Colourists. Jour. 61: 113-117. May 1945. 306.9 So1

Includes effects of temperature and moisture content on two viscose rayons, Tenasco and Durofil, when used as tire cords.

SCHOLES, A. Tyre cords - cotton and rayon. Textile Inst. Jour. 35: P99-P110. Oct. 1944. 73.9 T31

Includes discussion of effects of moisture on strength of cords.

SMITH, K. D. High flex cord in bus and truck tires. Rubber Age 42: 177-178. Dec. 1937. 305.8 R82

Characteristics and advantages of a flex- and heat-resistant tire cord manufactured by the B. F. Goodrich Co.

SPRINGER, A. Testing of textiles in the rubber industry. Gummi-Ztg. 55: 813-815. 1941.

Descriptive summary of investigations. - Chem. Abs. 36: 7223. Nov. 20, 1942. 381 Am33C

STAVELY, F. W., and SHEPARD, N. A. Some methods of studying cord tire fabric. Indus. and Engin. Chem. 19: 296-301. Feb. 1927. 381 J825

Hysteresis and flexing as fatigue tests. Brief section on effects of temperature and humidity on flexing life shows increase of flexing life with increasing relative humidity, and decrease of flexing life with increase in temperature.

STOLL, L. The influence of the temperature on the strength of fabrics. Gummi-Ztg. 43: 2218-2231. 1929.

"Sample of fabric cords were heated at 60°, 80°, 100°, 110°, 140°, 150°, 170°, 200°, and 220° for 0.25, 2, 4, 6, 8, and 15 hours and the elongation and breaking strength before and after the heating determined. The experimental results which are recorded in tables and graphs, admit of certain general conclusions. The higher the temperature and the longer the time of heating the greater is the loss in breaking strength and in elongation. Even after 15 minutes heating there was a considerable loss of strength, viz., around 4% at 100°, 12% at 150°, and 20% at 200°. Up to 110° the loss in elongation and strength may be considered relatively small, while at 140°-150° the loss of strength becomes considerable, e. g., around 15% after 2 hours." - Chem. Abs. 23: 4370. Sept. 10, 1929. 381 Am33C

TILTMAN, A. H., and PORRITT, B. D. The effect of heat on cotton. Initial changes in tensile strength of unproofed fabric. India-Rubber Jour. 76: 245-248. Aug. 18, 1928. 305.8 In21

Report of experiments showing that (1) a permanent loss of strength occurs when unproofed cotton fabric is heated to temperatures above 120°C.; (2) loss of strength increased with temperature until, at about 240°C., almost total destruction occurs within 4 hours; (3) effect of heat on tensile strength is roughly proportional to the duration of heating; (4) heating in air increases detrimental effects; exclusion of air minimizes loss of strength; (5) elastic properties of cotton apparently are not affected by heat; only the breaking point.

TRUESDALE, R. A. The influence of heat on physical properties of yarns. Textile Recorder 40(472): 52-54. Aug. 15, 1922. 304.8 T311

Results from experiments showed the following: (a) That after a period of one hour, cotton heated in a moist heat at 140°C., is reduced in strength; (b) that yarn changes its color when heated for one hour at a temperature of 120°-140°C.; (c) that a time factor operates with the temperature factor in weakening the yarns; (d) that cotton treated in a small vessel containing the moisture of hydration is weakened more than that heated in dry heat.

U. S. CONGRESS. SENATE. SPECIAL COMMITTEE INVESTIGATING THE NATIONAL DEFENSE PROGRAM. Comparative merits of rayon and cotton tire cord. Additional report .... pursuant to S. Res. 71(77th Cong., and S. Res. 6, 78th Cong.). 78th Cong. 1st sess. Senate Rpt. 10, Pt. 11, 8 p. Washington, D. C., U. S. Govt. Print. Off., 1943.

Review and criticism of War Department tests purporting to show that rayon cords were superior to cotton for military tires. It is charged that the tests were unscientific and the results inaccurate and unreliable.

U. S. CONGRESS. SENATE. SPECIAL COMMITTEE INVESTIGATING THE NATIONAL DEFENSE PROGRAM. Investigation of the national defense program. Hearings, 78th Cong., 1st and 2d sess., pursuant to S. Res. 6. Pt. 21 ... Sept. 22, Oct. 28, Nov. 19, 24, Dec. 3, 1943; and Jan. 5, 7, 10, 1944. p. 8515-9285. Washington, D. C., U. S. Govt. Print. Off., 1944.

Rayon versus cotton cord for tires, testimony, p. 8515-8543; technical reports and data, p. 8899-8938. Test data and operating experience of transportation companies are summarized, showing superiority of rayon cord over cotton, for heavy-duty tires.

WAKEHAM, H., HONOLD, E., and SKAU, E. L. Comparison of some elastic properties of tire cords. Jour. Appl. Phys. 16: 388-401. July 1945. 334.8 P563

"The elastic behavior of nylon, of rayon, and of unstretched and stretched cotton tire cords are compared with respect to their rates of elongation during measurement of the stress-strain curves and their elongation under static loads at various temperatures between 25°C and 200°C. Elongations under the influence of cyclic loads are shown for cotton and rayon cords, and an apparatus for determining mechanical hysteresis of tire cords during cyclic loading is described. The temperature and moisture content of the cord are shown to have considerable effect upon its elastic properties." - Abs.

WESTBROOK, F. A., Jr. Use of rayon tire cord is expected to expand, but cotton will hold part of market. Textile Age 7(10): 38, 40, 42, 44, 46. Oct. 1943. 304.8 T3132

Includes discussion of heat effects on tire cords.

WIEGERINK, J. G. Effects of drying conditions on properties of textile yarns. Textile Res. 10: 493-509. Oct. 1940. 304.8 T293

Also in U. S. Natl. Bur. Standards Jour. Res. 25: 435-450. Oct. 1940. 157.88 J82

"Yarns made from raw cotton, 'purified' cotton, mercerized cotton, clothing wool, carpet wool, viscose rayon, cuprammonium rayon, cellulose acetate, and degummed silk were satuarated with water and then exposed for periods of 1/2 to 6 hours in air having temperatures of 221°, 257°, and 302°F. and absolute humidities of approximately 1, 55, and 95 percent, respectively. After conditioning the dried yarns for at least 24 hours in air of 65-percent relative humidity and 70°F. measurements were made of the breaking strengths, elongations at break, and moisture contents of the yarns; the fluidities of dispersions of the cellulosic fibers in cuprammonium solution, of the silk in aqueous zinc chloride, and of the acetate in aqueous acetone; and the relative affinities of the cellulosic fibers for the dye benzopurpurine 4B and of the wools for acid dyes.

"Heating the yarns for 6 hours at 221°F. at each of the three humidities weakened all of them. The breaking strength and elongation at break of the viscose, cuprammonium, degummed silk, and cotton yarns decreased still more at higher temperatures. In comparison with heating at 1-percent absolute humidity, heating at 95-percent absolute humidity resulted in lower breaking strengths and elongations at break for all yarns except the raw cotton, higher fluidities, lower affinity of cellulosic fibers, and higher affinity of wool fibers for the dyes.

"Heating for 1/2 hours at 302°F. had little effect on the properties of the yarns except the viscose and cuprammonium rayon, which were adversely affected. The damage which occurred at a given temperature and humidity increased throughout the heating period." - Abs.

WIEGERINK, J. G. Moisture relations of textile fibers at elevated temperatures. U. S. Natl. Bur. Standards. Jour. Res. 24: 645-664. June 1940. 157.88 J82

Also in Textile Research 10: 357-371. July 1940. 304.8 T293

Determination of moisture content of 10 kinds of textile fibers at different temperatures and relative humidities. Statistical results given in a series of graphs.

YAMINSKAYA, E. Y. Effect of temperature on the properties of cords. Caoutchouc and Rubber 9: 49-52. 1940

"Cotton cord as a rule suffers a loss in strength on heating, whereas viscose cord does not lose its strength but even shows a tendency to increase in strength. Hence in constructing tires and belts it is necessary to consider the strength of the cord at the operating temperatures of the object rather than at the conditioning humidity and temperature." - Chem. Abs. 35: 930-931. Feb. 10, 1941. 381 Am33C

YERKES, L. A., JR. Rayon for tires. India Rubber World 101(3): 41-45, 49. Dec. 1, 1939. 305.8 In2

Properties of "Cordura" rayon, developed especially for tire fabrics, include high strength when hot and a very high resistance to fatigue.

U. S. PATENTS

No. 1,867,035. Process for making effect threads heat and storage proof. Issued to Ernst Stocker, assigned to Munitex Corporation. 1932

No. 1,902,871. Re-enforced vulcanized rubber articles and process of making the same. Issued to G. R. Lockhart, assigned to Manville-Jenckes Co. 1933.
Process for rendering threads of viscose rayon more resistant to heat during vulcanization.

No. 2,050,196; 2,050,197. Prevention of deterioriation of cotton cords by heat. Issued to L. B. Sebrell, assigned to Wingfoot Corporation. 1936.
Chemical treatments for increasing tensile strength of cotton cords under heat.

No. 2,103,218. Heat-resistant yarn and heat-resistant cord and process for making same. Issued to E. C. Gwaltney, T. A. Graybill, and R. B. Newton, assigned to Bibb Manufacturing Co. 1938.

No. 2,137,339. Process of manufacturing rubber impregnated fabric and the product thereof. Issued to E. C. Gwaltney, assigned to Bibb Manufacturin Co. 1938.
Description of a cotton cord possessing substantially constant tensile strength under varying moisture content.

No. 2,201,262. Process for treating cotton materials. Issued to W. H. Furness, assigned to American Rayon Co. 1940.
Chemical treatment to increase hot-flexing life of cotton cords.

No. 2,248,901. Tire cord. Issued to W. E. Vecsey, assigned to General Tire and Rubber Co. 1941.
Cords rendered heat-resistant by mercerization under low tension.

No. 2,257,732. Method of treating cellulose textile material. Issued to E. O. Ridgway and W. A. Bodenschatz, assigned to Ridbo Laboratories, Inc. 1941.
Chemical process of treating textile fibers to improve among other things, hot flexing life and tensile strength at both normal and high temperatures.

No. 2,254,740. Heat-resisting yarn and cord. Issued to A. W. Hansen and W. F. Guinan, assigned to United States Rubber Co., 1941.
Mercerization process for treatment of cord.

No. 2,254,741. Method of making heat-resisting yarn and cord, and the cord. Issued to A. W. Hansen and W. F. Guinan, assigned to United States Rubber Co., 1941.

No. 2,278,284. Stabilizing cellulose yarns. Issued to J. S. Reese, IV, assinged to E. I. du Pont de Nemours & Co. 1942.
Treatment of yarns with biuret.

No. 2,278,285. Stabilized cellulose yarns and method of preparing same. Issued to J. S. Reese, IV, assigned to E. I. du Pont de Nemours & Co. 1942.
Treatment of yarns with urea.

No. 2,346,126. Production of improved cellulosic cords and yarns. Issued to E. T. Lessig, and L. Larrick, assigned to B. F. Goodrich Co. 1944.
Process for making fatigue-resistant cords.

No. 2,372,601. Cotton cord. Issued to R. F. Nickerson, assigned to National Cotton Council of America. 1945(?)
Treatment for making cord resistant to heat and to drying out, thus increasing its breaking strength.

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